INDOOR AIR QUALITY ASSESSMENT

PACE Head Start Program
T.A. Green Building
32 Madison Street
New Bedford, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of Michelle Wilding, (Health Services Manager) and Karen Surprenant, Director of the PACE Head Start Program, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at their offices located at the T.A. Green Building, 32 Madison Street, New Bedford, Massachusetts. The request was prompted by concerns about mold as a result of excessively humid weather during the first three weeks of August 2003.

On September 24, 2003, a visit was made to this school by Cory Holmes, an Environmental Analyst in the Emergency Response/Indoor Air Quality (ER/IAQ) program, BEHA, to conduct an indoor air quality assessment. The T.A. Green Building is a three-story brick school built in the early 1900's. Renovations to the building in 1992 included the construction of a 3rd floor conference room and an upgrade of the building's ventilation system. School officials reported that brickwork around the chimney and the front stairs were recently repointed. Windows are openable throughout the building.

Methods

BEHA staff performed visual inspection of building materials for water damage and/or microbial growth. Moisture content of carpeting was measured with Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The school has a preschool population of approximately 200 and a staff of approximately 60. The tests were taken during normal operations. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million of air (ppm) in twenty-one of twenty-six areas surveyed, indicating adequate ventilation in most of the areas surveyed. It is important to note that mechanical ventilation was deactivated during the assessment to limit the introduction of humid outdoor air while window mounted air conditioners were operating in each classroom. Limiting outside air intake can contribute to an increase in carbon dioxide levels.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (Picture 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (Picture 2) and return air through an air intake located at the base of each unit (Figure 1). Fresh and return air are mixed, filtered, heated or cooled and provided to classrooms through an air diffuser located in the top of the unit. Adjustable louvers control the ratio of outside to recirculated air. As discussed, univents were deactivated in classrooms throughout the building preventing the introduction of fresh air. In order for univents to provide fresh air as designed, these units must remain "on" and allowed to operate while rooms are occupied. In addition, air diffusers and return vents must remain free of obstructions.

The mechanical exhaust ventilation system consists of wall-mounted exhaust vents connected to exhaust fans on the roof. This system was operating during the assessment. Items such as wastebaskets were obstructing exhaust vents in several classrooms (Picture 3). As with the univents, exhaust vents must remain free of obstructions to function as designed.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The initial equipment balancing should have occurred after the installation of the new HVAC systems in 1992. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994).

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix A.

Temperature measurements ranged from 71^{o} F to 78^{o} F, which were within the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 38 to 51 percent, which was close to the BEHA recommended comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

In the experience of BEHA staff, excessively humid weather can provide enough airborne water vapor to create adequate conditions for mold growth in buildings. Relative humidity in excess of 70 percent can provide an environment for mold and fungal growth (ASHRAE, 1989). In general, materials that are prone to mold growth can become colonized when moistened for more than 24-48 hours. Since hot, humid weather persisted in Massachusetts for more than 14 days during the month of August (The Weather Underground, 2003), materials in a large number of schools and buildings were moistened for an extended period of time. As a result of this humidity, mold growth occurred in this building in two basement classrooms on the surface of carpeting and non-porous items such as walls, chairs and tables as reported by PACE staff. PACE officials hired Serv Pro, a professional carpet-cleaning firm to clean the mold and disinfect carpeting with a fungicide. All non-porous items/surfaces were reportedly cleaned and disinfected. No evidence of active mold growth, elevated moisture content in carpeting or associated odors were detected by BEHA staff at the time of the assessment.

The US Environmental Protection Agency and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24-48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Several classrooms had a number of plants. Moistened plant soil and drip pans can be a source of mold growth. Classroom 3 had plants on top of paper towels that were saturated with water. Plants should be equipped with drip pans. Paper towels are a porous material that can be colonized by microbial growth, especially if wetted repeatedly. Plants are also a source of pollen. Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom.

Spaces between the sink countertop and backsplash were noted in several areas (Table 1/Picture 4). Improper drainage or sink overflow could lead to water penetration of countertop wood, the cabinet interior and behind cabinets. If porous materials become wet repeatedly they can provide a medium for mold growth.

Water coolers and water fountains were installed over carpeting (Pictures 5 & 6). Spills from water coolers/fountains can result in wetting of the carpet, which can lead to mold growth especially if wetted repeatedly.

Carbon Monoxide/Exhaust Emissions

PACE officials reported that the school had experienced issues with exhaust emissions from the natural gas water heater in the basement. Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and natural gas). BEHA conducted air sampling for carbon monoxide. *Carbon monoxide should not be present in a typical, indoor environment.* If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). Measurable levels of carbon monoxide below the NAAQS and MDPH corrective action level were detected in the boiler room and in the hallway outside of the boiler room (Table 1).

Exposure to carbon monoxide can produce immediate and acute health affects. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within the rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The US Environmental Protection Agency has established National Ambient Air Quality Standards (NAAQS) for exposure to carbon monoxide in outdoor air. According to the NAAQS established by the USEPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average.

Several measures were reportedly taken to address water heater exhaust odor within the building. The water heater was professionally serviced and the exhaust ventilation improved. In addition, a portable carbon monoxide (CO) detector was installed in the hallway outside the boiler room (Picture 7). This monitor is not equipped with a digital readout but is designed to sound an alarm when CO concentrations reach a certain pre-programmed level.

The bulkhead door to the boiler room was open during the assessment (Picture 8). The production of exhaust emissions in combination with cold air moving from outdoors through open exterior doors can pressurize the boiler room. Positive pressure within a room will force air and pollutants through spaces around doors, utility pipes and other holes in walls, doors and ceilings (Picture 9). To reduce airflow into the adjacent areas, sealing of these potential pathways should be considered.

Other Concerns

A number of exhaust/return vents were noted to have accumulated dust. If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize accumulated dust particles. Dusts can be irritating to the eyes, nose and respiratory tract.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Although cleaning may have removed microbial growth from the carpet, further growth can be expected to occur once water moistens carpet in below grade areas. To avoid this occurrence, consider removing carpeting from below grade areas where mold was detected prior to the cleaning.
2. Consider using a carbon monoxide detector with a digital readout in place of the alarm only model in the basement.
3. Keep exterior doors to boiler room shut and seal utility holes and other potential pathways for air to migrate into adjacent areas.
4. Contact utility provider and/or professional heating contractor to ensure local exhaust system in the boiler room is functioning properly and make improvements as necessary.
5. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
6. Remove all blockages from univents and exhaust vents to ensure adequate airflow.

7. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994). Consult a ventilation engineer concerning re-balancing of the ventilation systems.
8. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).
9. Move plants away from univents in classrooms. Ensure all plants are equipped with drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.
10. Install a water impermeable barrier (e.g., rubber/plastic) beneath water fountains/coolers to prevent water damage/mold growth to carpeting.
11. Clean exhaust/return vents periodically to prevent excessive dust build-up.
12. In order to maintain a good indoor air quality environment on the building, consideration should be give to adopting the US EPA document, "Tools for Schools". This document can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.
13. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

References

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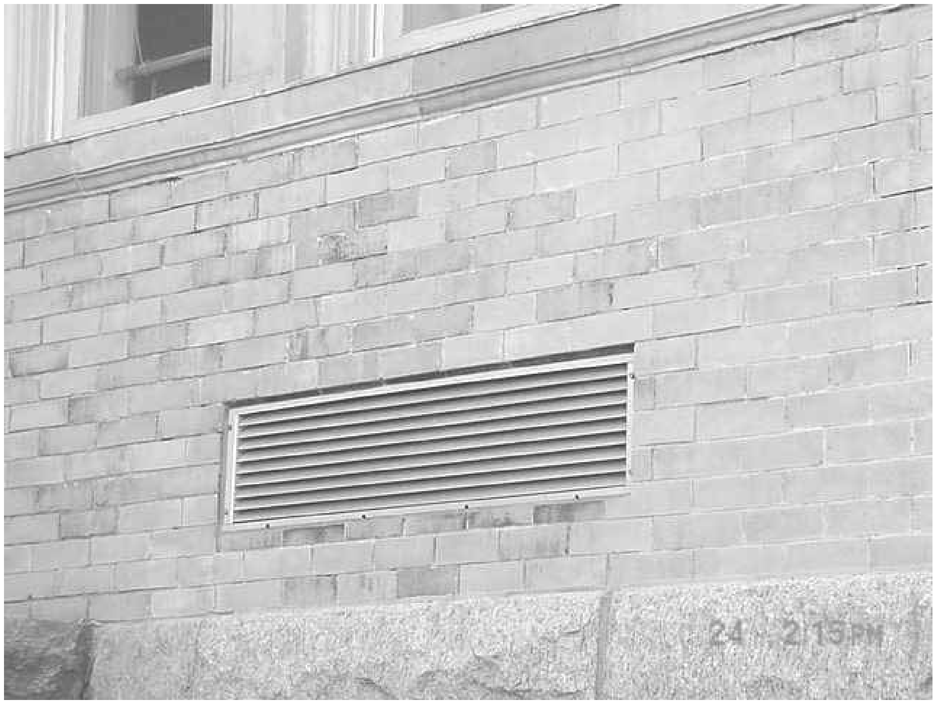
Picture 1

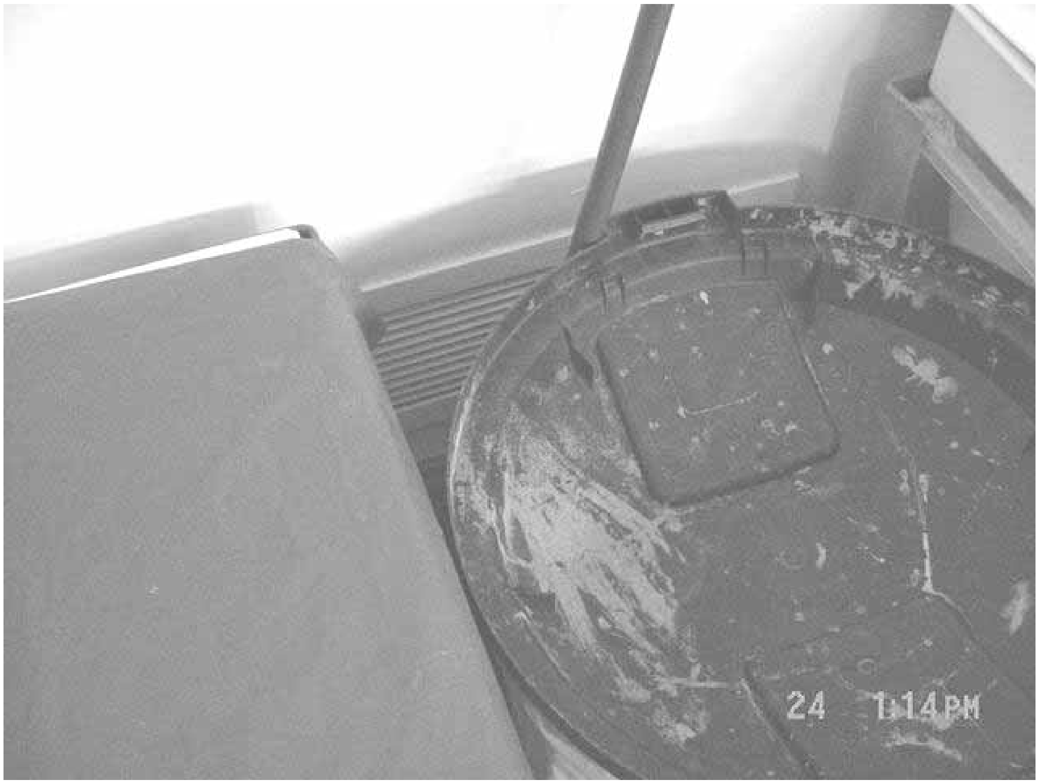
Typical Classroom Univent

Picture 2



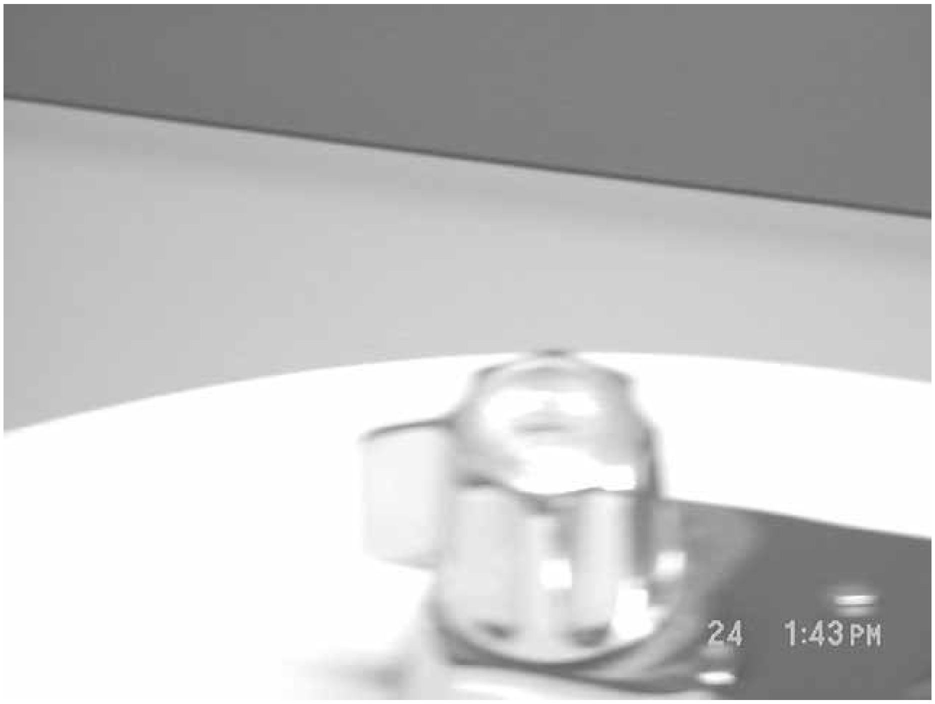
Univent Fresh Air Intake

Picture 3



Obstructed Classroom Exhaust Vent

Picture 4



Spaces Between Sink Countertop and Backsplash

Picture 5

Water Fountain Over Carpeting

Picture 6

Water Cooler on Carpeting

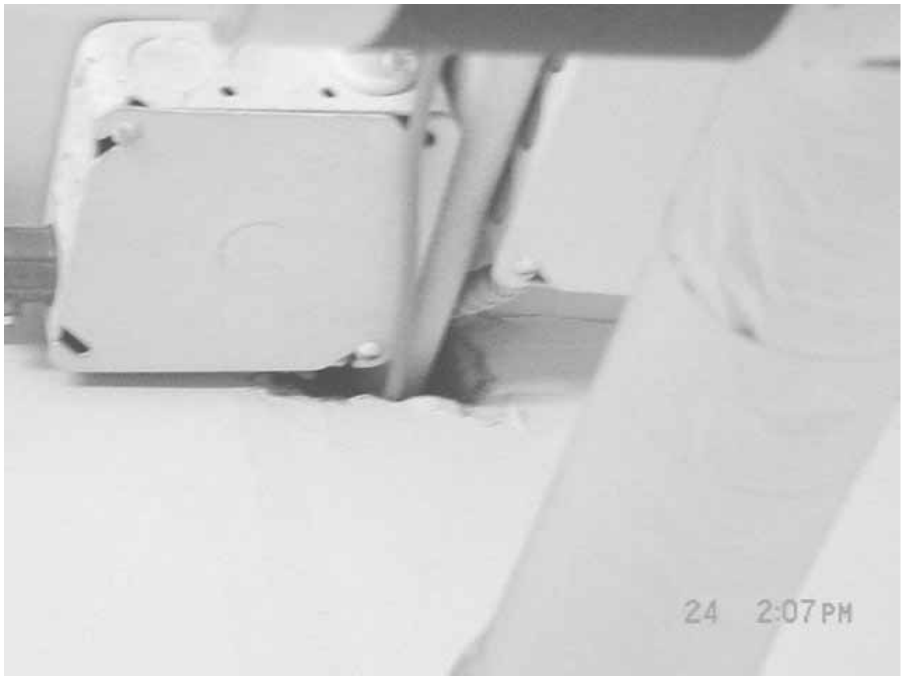
Picture 7

Wall-Mounted Carbon Monoxide Detector

Picture 8

Open Bulkhead and Entrance to Boiler Room

Picture 9



Open Utility Hole in Boiler Room

TABLE 1

Indoor Air Test Results – PACE Head Start Program – New Bedford   Date: 09/24/03

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Outside (Background)	412	ND	74	36					-Clear skies -NE winds 5-10
Room 1	866	ND	72	48	5	Y	Y	Y	-Window AC -EX vent blocked by barrel -Missing caulking sink
Room 2	610	ND	72	41	0	Y	Y	Y	-EX vent blocked by trash barrel
Room 3	1066	ND	73	40	14	Y	Y	Y	-Plants – plants on paper towels -Missing caulking sink
Room 4	790	ND	71	38	1	Y	Y	Y	-UV off, Items on UV, Guinea pig, AC, Dirty/dust build-up on EX vents
Main Office	506	ND	74	45	3	N	Y	Y	
Boys Restroom		ND	74	44	0	Y	N	Y	-Floor drain -Window open
Girls Restroom		ND	75	45	0	Y	N	Y	-Window open -Missing caulking sink back splash
Room 6	724	ND	75	45	10	Y	Y	Y	-DO

*** ppm = parts per million parts of air**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Table 1-1

TABLE 1

Indoor Air Test Results – PACE Head Start Program – New Bedford Date: 09/24/03

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Karen's Office	560	ND	75	43	1	Y	N	N	-AC
Room 5	1244	ND	78	48	9	Y	Y	Y	-AC -UV off (deactivated)
Education Office	882	ND	76	48	4	N	Y	Y	-AC -Dusty EX vent
Room 7	690	ND	75	40	1	Y	Y	Y	-EX partially blocked
Room 8	988	ND	75	41	18	Y	Y	Y	-UV - deactivated
2nd Floor Boy's Restroom		ND	75	41	0	Y	Y	Y	-Window open
2nd Floor Girl's Restroom		ND	76	48	0	Y	Y	Y	-Window open
2nd Floor Women's Restroom		ND	76	47	0	N	N	Y	
2nd Floor Men's Restroom		ND	76	46	0	N	N	Y	
3rd Floor Men's Restroom		ND	75	47	0	N	N	Y	

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Relative Humidity -	40 - 60%

Table 1-2

TABLE 1

Indoor Air Test Results – PACE Head Start Program – New Bedford Date: 09/24/03

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
3rd Floor Women's Restroom		ND	74	40	0	N	N	Y	-Missing caulking sink/backsplash
Conference Room	638	ND	74	48	5	N	Y	Y	
Family Services D	529	ND	75	44	1	N	Y	Y	
Basement Hallway		1-2							-Carbon Monoxide detector (American Sensors)
Boiler Room		6							-Open utility holes -Blocked/ EX door open -Natural gas boilers
Health Office	588	1	76	42	5	N	Y	Y	
Family Services E	533	ND	75	42	0	N	Y	Y	
Family Services F	540	1	74	43	0	N	Y	Y	
Family Service G	485	ND	74	41	1	N	Y	Y	

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Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Staff Lounge	440	ND	74	41	1	N	Y	Y	
Kitchen	506	ND	75	44	1	Y	Y	Y	
Parent Involvement Coordinator Office	649	ND	74	51	0	N	Y	Y	
Nursery	592	ND	73	48	0	Y	Y	Y	
Room 0	643	ND	75	47	17	Y	Y	Y	-No visible mold growth or associated odors -Low moisture content carpet
Hallway		ND							-Dehumidifier
Room 9	578	ND	74	42	6	Y	Y	Y	-No visible mold growth or associated odors, low moisture content carpet -Dust accumulated on insulation

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TABLE 1

Indoor Air Test Results – PACE Head Start Program – New Bedford Date: 09/24/03

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Family Services A	551	ND	74	43	0	N	Y	N	
Family Services B	518	ND	75	44		N	Y	Y	
Family Services C	540	ND	74	43	0	N	Y	Y	

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